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OPTICAL PACKET SWITCHING DEMOSTRATOR

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Abstract *In the IST project DAVID (Data And Voice Integration over DWDM) work is carried out defining possible architectures of future optical packet switched networks. The feasibility of the architecture is to be verified in a demonstration set-up. This article describes the demonstrator set-up and the measurement metrics that will be used to evaluate the demonstrator.*

Introduction

The network studied in the DAVID project is divided into a backbone or core part (hereafter WAN) and an access metropolitan area network (hereafter MAN). The WAN network topology is mesh-based and the MAN network is ring-based. See figure 1.

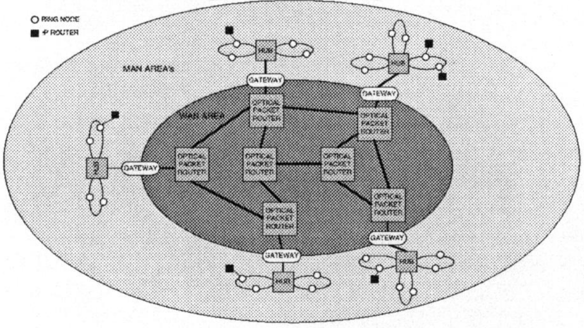

Figure 1 The DAVID network concept

Both networks operate in a time slotted approach, with optical packet lengths of 1 us. In addition to this, DWDM is also used to provide a large amount of bandwidth between the nodes. The optical packets in both MAN and WAN are divided into a header and a payload that can operate a various bit rates.

In the MAN physically disjointed rings are connected through a HUB that consists of an optical space switch with no internal buffer capacity. Each ring carries multiple wavelengths of which one is dedicated to transport control data (Media Access Control, MAC) for all the ring nodes. The MAC channel informs each ring node whether is can send a packet or if it has to receive the packets arriving in the following timeslot. The space permutations of the HUB are announced on the MAC channel as well, such that the ring nodes can determine if they have traffic destined for one of the possible rings in the following timeslot. The MAC part of the project are among others studied in [1][2]. At each ring node a number of IP routers are connected providing access to legacy/enterprise networks.

In the WAN, packets are switched transparently through the optical packet routers. Since traffic is not scheduled globally among the OPRs (Optical Packet switched Router) the switch nodes need to have buffering capabilities in order to solve output contention. The bandwidth defined for the WAN is 40Gb/s compared to 10Gb/s for the MAN.

The WAN and MAN are connected through a gateway which adapts both between bandwidths and packet formats.

Motivation for the DAVID demonstrator

The main objectives of building the demonstrator are listed below:

1. Test of the WAN concept, implementing optical packet switching.
2. Test of the MAN concept, implementing a multi-ring multi-QoS packet switched ring.
3. Test of the interconnection between the MAN and the WAN, providing packet adaptation and buffering.
4. Verification of the physical feasibility, optical synchronization and regeneration.
5. Experimental traffic studies.

The demonstrator bandwidth is limited to 10Gb/s for the WAN part and MAN part, while a maximum bandwidth to each MAN ring node of 2.5Gb/s. The MAN part is simplified in the sense that each physical disjointed ring has one common downstream waveband and one common upstream waveband. The downstream waveband is optically split at each ring node such that all ring nodes see the same signal over time. The upstream wavebands are optically combined at all ring nodes as well. This approach is illustrated in figure 2.

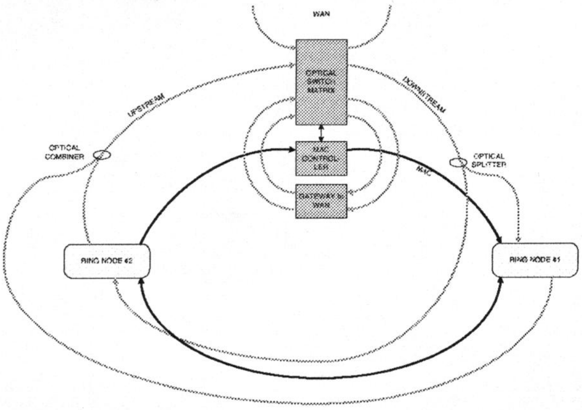

Figure 2 The demonstrator concept (simplified)

The MAC channel is terminated/generated in every ring node, enabling the ring nodes to send requests for bandwidth to the MAC channel controller. In figure 2 the HUB is merely a switch to/from the WAN network. When packets are destined for the WAN they go through the "GATEWAY to WAN" controller that performs packet format adaptation and buffering. Since the optical switch matrix is bit rate transparent, it is used for both switching of WAN and MAN traffic. Shown in figure 3 is a set-up with two physical disjointed rings connected to the HUB.

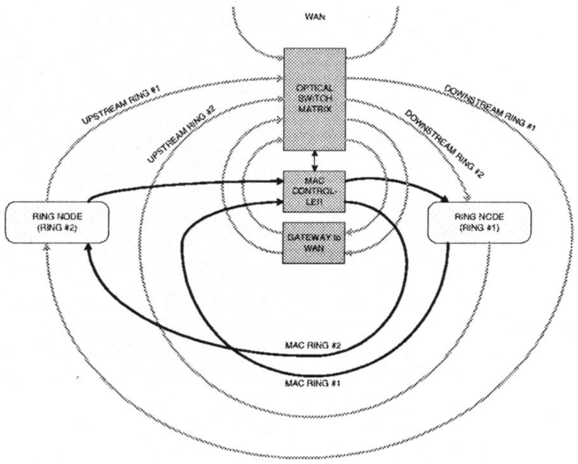

Figure 3 Two-ring demo set-up (simplified)

In both figure 2 and 3 the ring nodes are connected to two separate legacy networks through two gigabit Ethernet connections. This provides each ring node with an aggregate bandwidth of 2Gb/s. The legacy networks consist of a number of PCs running both client and server applications. Among the applications that will be tested in the DAVID demonstrator are: HTTP, Video streaming, VoIP and FTP.

QoS in the ring nodes

Provision of Quality of Service, QoS, is obtained by the Differentiated Services [3] approach for IP networks. The Ring node performs the packet classification in order to assign the Diff-Serv class. A high performance network processor that performs wire speed multi field analysis of layer 3 - layer 7 header information, handles the classification tasks.

The MAC protocol supports three QoS levels; a certain amount of bandwidth is assigned to the highest priority. The second priority makes use of a reservation scheme, and finally, the third priority supports only best effort traffic. The mapping between Diff-Serv classes and MAC QoS levels is straightforward: Expedited Forwarding EF is mapped to MAC level 1, Assured Forwarding AF is mapped to MAC level 2 and Best Effort BE is mapped to MAC level 3. The data flow in the ring node is shown in figure 4. One of the main issues in the ring node is the generation of fixed length optical packets from variable length Ethernet packets; the variable length packets are cut into fixed length segments similar to ATM segmentation.

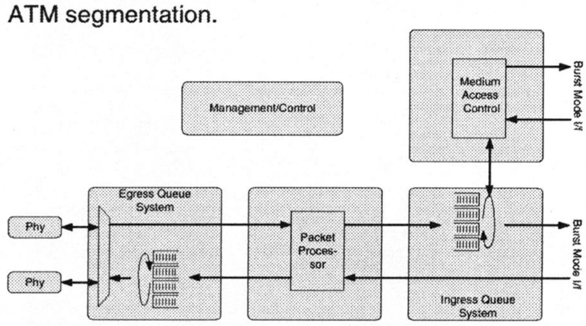

Figure 4 Data flow in ring node

The small segments are then collected to form an optical packet. There is a tradeoff between the delay of a segment and the filling efficiency of the optical packet. This issue has been investigated by simulations, and it will be compared to real measurements. When the need for bandwidth increases, multiple wavebands can be introduced using the concept illustrated for ingress traffic on figure 5 (MAC channel not shown).

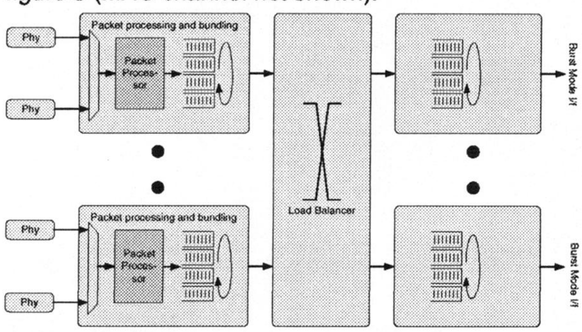

Figure 5 Multiple waveband concept

To distribute the load among the wavebands, a load balancer is inserted between the legacy- and MAN interfaces.

Conclusions

Given the description above a number of exiting demonstration set-ups have been defined in order to evaluate the feasibility of optical packet switched networks. First test assembly of the demonstrator is scheduled to May 2002 with final concept demonstration finishing May 2003. The demonstrator overview given in this article will thus be followed by measured results in the near future.

For further information about the DAVID project see http://david.com.dtu.dk/

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